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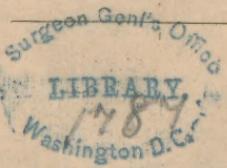
ARMY RATION.

HOW TO DIMINISH ITS WEIGHT AND BULK, SECURE ECONOMY IN
ITS ADMINISTRATION, AVOID WASTE, AND INCREASE THE
COMFORT, EFFICIENCY, AND MOBILITY OF TROOPS.
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At the request of officers connected with the administration of the Medical and Subsistence Departments of the Army, and of field officers long in the service, I have been induced to investigate the problem of the Army Ration. As the result of my researches, the details of which are presented in the following pages, it appears that with great saving to the country and increased comfort to the soldier, the present marching ration, weighing 32 or 40 ounces, and occupying about 100 cubic inches, may be reduced in weight to 18 or 16 ounces, and in bulk to 35 cubic inches, without any diminution of nutritive value; and this not by means of concentrated extracts of food, but simply by removing the inedible portions and the water, and by compression.

E. N. HORSFORD.

CAMBRIDGE, April 20, 1864.

THE ARMY RATION.

The imperfect adaptation of the army ration at the close of the war of 1812 has been recognized by Congress. Repeated Acts, and more than one since the outbreak of the rebellion, have been passed, modifying its substance and quantity. The old ration of the British army, upon which our earlier ration, including the allowance of spirits, was doubtless based, differs somewhat from ours as now constituted, but much more from the rations of the French and other continental armies. All are undergoing greater or lesser changes with the experiences of each new campaign; but, aside from this consideration, there are various other reasons why we cannot rely for guidance in the subsistence department upon the usages of the armies of the Old World.

Throughout Europe, independent of the railways, there are high roads connecting all the more important points, uniformly broad, hard, of easy grade, with stone bridges, and so thoroughly made as not to be affected by rains, along which men and supplies may be moved with facility. Villages are frequent. Public bakeries are to be found ready for use at short intervals. Sutlers can keep pace with the armies. Scarcely any extensive district can be found from which most of the staple commissary supplies may not be derived. The peasantry—from which class the rank and file of the armies are drawn—are accustomed to the black rye bread which is the chief article of diet in the European soldier's fare.

Here, the case is different. Our theatre of war is one of vast distances; of relatively sparse population, and indifferent wagon-roads. During a full third of the year, the roads of the South are rendered quite impassable to artillery and wagon-trains by a single heavy rain. They are without solid bed, narrow, and rapidly cut up by heavily pressed wheels. On the march, the army wagons containing the cooking utensils, and the sutlers' wagons, are

usually at long distances in the rear. They are of course, liable to be cut off by the enemy's cavalry. For these and other reasons connected chiefly with the difficulties of transportation, the rations are not unfrequently reduced greatly in quantity and quality at most critical moments. Town bakeries are unknown in our southern villages. Even small collections of houses, scarcely rising to the rank of villages, are widely separated from each other. Our supplies are of necessity sometimes drawn from points thousands of miles from the field of army operations. Our soldiers have not been accustomed at home to the simple and coarse fare of the peasantry of Europe, and not until they have been a year or more in the service do they become wholly suited to the plain, though in the main, nutritious fare of the active soldier.

These considerations, and the every day increasing importance of economy in our resources for the suppression of the rebellion, naturally suggest the examination of the whole subject of the ration from a scientific point of view.

WHAT DOES THE SOLDIER REQUIRE?

The experience of civilized life has shown that the human organism requires, to maintain it in health, both *organic* and *inorganic* food. Of the organic, it needs nitrogenous food for the support of the vital tissues, *for work*; and saccharine or oleaginous food for *warmth*. Of the inorganic, it needs phosphates for the bones, brain, muscles, and blood; and salt for its influence on the circulation and secretions, and for various purposes where soda is required as a base, and doubtless both phosphate and salt for many offices as yet imperfectly understood. "A man may be starved by depriving him of phosphates and salt, just as effectively as by depriving him of albumen or oil." (Dalton's *Physiology*.) The salts of potassa, magnesia, and iron, of manganese, silica, and fluorine, are always present, and perform services of greater or less obvious moment in the animal economy.

These organic and inorganic substances are essential, but they are not all that are needed. Man, especially when compelled to exhausting labor, requires beverages and condiments. He wants coffee, or tea, or cocoa, or in the absence of these he may feel a craving for wine or spirits. He wants salt, pepper, and vinegar.

To preserve a sound mind in a sound body, then, there are required organic and inorganic food, beverages, and condiments.

WHAT IS THE ARMY RATION?

The present ration consists, substantially, of—

Bread,

Meat,

Coffee, and

Sugar.

The bread may be issued as *flour*, to be resolved at the soldiers' option into loaf bread baked in camp, biscuit, fritters, &c., as convenience or inclination may dictate; or as

Loaf Bread, baked at some of the bakeries of the Government or neighborhood, and transported as such to be distributed in camp; or as

Hard bread, which, baked without salt, in the form of crackers and kiln dried, is quite imperishable if kept from moisture.

The meat is *beef*, *fresh* or *salt*, and *salt pork*.

Coffee, without milk, is furnished roasted and ground.

Sugar is provided to be used with coffee, or as a condiment with other articles of diet.

Salt, *pepper* and *vinegar* are supplied in the needed quantities, and *vegetables* are furnished to the men in camp.

At first glance, the ration seems to fulfil every requisite. The organic and inorganic food are supplied in both the meat and bread. The nitrogenous and the respiratory food are present in the animal and vegetable fibrine and albumen, and in the oil, sugar, and starch of the meat and bread. The beverage of coffee is there; the salt, pepper and vinegar, as condiments or stimulants, are there; the sugar, more especially fulfilling the want of a saccharine or oleaginous constituent, is there. The ration has an apparent scientific as well as experimental foundation. It corresponds very nearly with the quantities and kinds established as essential by observation and experiment:

The supply found necessary to a man in full health consists of:

Meat.....	16 oz.
Bread.....	19 oz.
Butter or fat.....	3½ oz.
Water.....	52 oz.

The army ration consists, substantially, of:

Meat.....	16 oz.
Bread.....	22 oz.
Coffee and } Sugar, }	4 oz.

The extra bread and the sugar replace the butter or fat; and the coffee, besides affording an agreeable drink, exerts an antisep-tic influence over the living tissues, retarding their decay.

The principal armies of the world differ in the composition of their rations, but in the main show a general approximation to the theoretical requirement. The following table exhibits the rations of the more important armies in active service:

	American.	Austrian.	Bava- rian,*	British in Cri- mea.	British in India.	French.	Russian in Cis- mea.	Prus- sian.
Flour.....	22 oz. or 20 oz. or 22 oz. or 16 oz. ...	165 oz. 230 oz. 16 oz. ...	24 oz. or 16 oz. 16 oz. or 16 oz. or	22.83 oz. and } 3.52 oz. } 26.43 oz. or 10.78 oz. or 16 oz. or 16 oz. or	16 oz. or 32 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 32 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 32 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 32 oz. or 16 oz. or 16 oz. or 16 oz. or
Cornmeal.....	20 oz. or 12 oz. ...	32 oz. + 4 oz. + 16 oz. ...	17.16 oz. 3.10 oz. 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. 16 oz. or 16 oz. or 16 oz. or 16 oz. or	10.78 oz. or 8.47 oz. ...	4 oz. ...	4 oz. ...	4 oz. ...
White Bread.....	20 oz. or 12 oz. ...	4 oz. + 16 oz. ...	3.10 oz. 16 oz. or 16 oz. or 16 oz. or 16 oz. or	2 oz. or 4 oz. ...	2.11 oz. or other vegeta- bles. 2.11 oz. ...	2.11 oz. or other vegeta- bles. 2.11 oz. ...	2.66 oz. or 8 oz. or 5.3 oz. ...	2.66 oz. or 8 oz. or 5.3 oz. ...
Hard Bread.....	16 oz. ...	... ...	... ...	16 oz. ...	16 oz. ...	16 oz. ...	16 oz. ...	16 oz. ...
Black Rye Bread.....	20 oz. or 16 oz. ...	... ...	... ...	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or
Fresh Beef.....	20 oz. or 16 oz. ...	... ...	... ...	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or
Salt Beef.....	16 oz. ...	... ...	... ...	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or
Salt Pork.....	16 oz. ...	... ...	... ...	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or
Potatoes.....	16 oz. ...	... ...	... ...	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or
Rice.....	16 oz. ...	... ...	... ...	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or
Barley.....	16 oz. ...	... ...	... ...	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or
Peas.....	16 oz. ...	... ...	... ...	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or	16 oz. or 16 oz. or 16 oz. or 16 oz. or 16 oz. or
Beans.....	16 oz. ...	0.64 gill. or 1 oz. 2 times weekly.	... ...	1 oz. ...	1 oz. ...	0.9 oz.	0.9 oz.	0.9 oz.
Oatmeal.....	16 oz. ...	... ...	... ...	1 oz. ...	1 oz. ...	1.45 oz.	1.45 oz.	1.45 oz.
Desiccated Vegetables.....	16 oz. ...	... ...	... ...	0.25 oz. ...	0.25 oz. ...	0.43 oz. or 0.43 oz. ...	0.43 oz. or 0.43 oz. ...	0.43 oz. or 0.43 oz. ...
Cabbage or Sauerkraut.....	16 oz. or 24 oz. ...	... ...	... ...	0.5 gill. ...	0.5 gill. ...	1.75 gill.	1.75 gill.	1.75 gill.
Coffee, green.....	1.6 oz. or 2.4 oz. ...	... ...	... ...	1 oz. ...	1 oz. ...	1/3 oz.	1/3 oz.	1/3 oz.
Tea.....	1.6 oz. or 2.4 oz. ...	... ...	... ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...
Brandy.....	1.6 oz. or 2.4 oz. ...	... ...	... ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...
Rum.....	1.6 oz. or 2.4 oz. ...	... ...	... ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...
Wine.....	1.6 oz. or 2.4 oz. ...	... ...	... ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...
Beer.....	1.6 oz. or 2.4 oz. ...	... ...	... ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...
Tobacco.....	1.6 oz. or 2.4 oz. ...	... ...	... ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...	1 oz. ...
Sugar.....	2.4 oz. ...	... ...	... ...	0.10 oz. ...	0.10 oz. ...	0.10 oz. ...	0.10 oz. ...	0.10 oz. ...
Vinegar.....	0.32 gill. ...	... ...	... ...	0.05 oz. ...	0.05 oz. ...	0.31 oz. ...	0.31 oz. ...	0.31 oz. ...
Lime Juice.....	0.32 gill. ...	... ...	... ...	0.10 oz. ...	0.10 oz. ...	0.62 oz. ...	0.62 oz. ...	0.62 oz. ...
Mustard.....	0.04 oz. ...	... ...	... ...	0.05 oz. ...	0.05 oz. ...	0.9 oz. ...	0.9 oz. ...	0.9 oz. ...
Horseradish.....	0.06 oz. ...	... ...	... ...	0.06 oz. ...	0.06 oz. ...	0.9 oz. ...	0.9 oz. ...	0.9 oz. ...
Salt.....	0.06 oz. ...	... ...	... ...	0.06 oz. ...	0.06 oz. ...	0.9 oz. ...	0.9 oz. ...	0.9 oz. ...
Candles.....	16 oz. ...	... ...	... ...	16 oz. ...	16 oz. ...	16 oz. ...	16 oz. ...	16 oz. ...
Soap.....	64 oz. ...	... ...	... ...	100 rations.	100 rations.	18 oz. ...	18 oz. ...	18 oz. ...
Wood.....	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...

* Rumford's Essays, 1795.

† Hard bread generally used on the march. An allowance of from 5 to 10 cents each day is made to each soldier, with which to buy meat (generally 4 ounces) and vegetables for soup.

The Prussian ration, with the exception of the bread, which is issued once in four days, is purchased with a small allowance of money, by a commission consisting of one colonel, one captain, one lieutenant, and four sergeants. The principal form of food with the Prussian, French, Austrian, and Bavarian soldier, is soup. In the French ration, coffee is extra. The other parts of the ration are varied according to circumstances. The Russian Government furnishes bread, brandy, half the meat, and the rest is furnished by the soldier.

Our ration is eminently flexible. The pork and beef may replace each other. When volunteers come first to the field, fresh from the variety of home and markets of comparatively easy access, they demand, of salt meats, beef rather than pork. But veterans prefer pork. The reason is obvious. The fat of the pork, cooked or uncooked, takes the place of butter, and fulfils the want of an oleaginous constituent in the food. It also enables the soldiers to cook mutton or poultry that fall in their way on the march or on foraging expeditions. There is another reason why they prefer pork; its fat retards the penetration of the gastric juice, and it continues longer the sense of fullness in the stomach.

Salt Meats.—Let us look a little further. Salt meats have this great advantage, when properly cured—that they do not decay, in the ordinary sense of the term, and become offensive to taste and smell; but they experience another kind of deterioration. Dr. Thompson, of Glasgow, observed many years ago that the brine of salt meats had parted with its saltpetre and become charged with phosphates and sulphates. The latter constituents had been withdrawn from the tissues in the very process of curing. This change takes place inevitably with the salt meats shipped with our navy and merchant marine, and supplied to our soldiers; and the effect of the protracted use of salt meats in the production of scurvy has long been observed. This effect, though more generally remarked as incident to long voyages, has appeared repeatedly in our armies, where for considerable periods the men have lived on salt pork and hard bread, as at Fair Oaks, Cumberland Gap, Lookout Valley, and before Charleston.

Fresh beef, as ordinarily served from the butcher's stall, is rec-

ognized as one of the most acceptable and healthful of all the forms of meat ; but slaughtered and then immediately served up, as it uniformly is in camp, rarely, except in winter, having time to cool, it is proverbially less healthful than if slaughtered and kept till it has had experienced a sort of spontaneous curing. Butchers usually keep their dressed meats for days, and sometimes for weeks, before supplying them to customers.

This evil is, however, much less than that of the effects of transportation by railroad or on shipboard, where a condition of fright, and in the latter case of sea-sickness in addition, is maintained for days together. Cattle weighing 1,500 pounds on the hoof in Chicago are estimated to lose 200 pounds of dressed meat in transportation in the cars to Boston. They lose but little less in being brought to New York or Washington. The fine cattle sent by the subsistence department from New York to supply the troops at Hilton Head, also lost, on an average 200 pounds a head. It is not alone the loss in weight, but the great deterioration in quality, that is to be considered. It is shown by Medical Inspector Hamlin, in his notes on the "Alimentation of Armies," that "the flesh of mammalia undergoes a great change in its nutritive qualities by reason of fasting, disturbance of sleep, and long continued suffering, resulting in its becoming not only worthless but deleterious." This is also shown by the experiments of Claude Bernard, and is substantiated by history and every day life. Bull-baiting was once authorized by law to make the meat tender, and cattle and buffalo are run down for the same object. The meat of moose and deer, shot in the tracks, is known to be healthful ; while if the animals are run down the meat rapidly perishes, and if eaten frequently produces sickness.

Raised bread, made from sound flour, with yeast before acetic or lactic fermentation has set in, carefully baked and served without long transportation or loss of its moisture, is beyond question one of the most agreeable preparations of farinaceous food. It is porous, and admits the saliva and juices of the stomach for ready digestion. But as it is bulky, and contains from thirty to fifty per cent. of water, its transportation any considerable distance, especially in the absence of railroads or where wagon-roads are bad, is attended with great expense and frequently with much

difficulty and irregularity. A wagon that will carry fifteen barrels of flour will carry but one seventh of this quantity in the form of freshly baked bread. If heaped in wagons as it comes from the oven, it packs and becomes heavy, sodden, and unpalatable. Issued once in four days, it becomes dry and hard before it is all consumed.

Hard bread, or "hard tack," has the advantage, when kept dry, of not being liable to decay, and may therefore be trusted to stay hunger where more perishable food would fail. But it is exceedingly bulky. A barrel that will contain 196 pounds of flour will hold but 75 pounds of hard bread. The daily ration is a formidable pile of more than 60 cubic inches. If wet, it rapidly becomes unfit for food, and frequently becomes mouldy when kept in moist places. When made from some kinds of flour, in which the starch or gluten, or both, assume a gelatinous character, and show, when baked and kiln-dried, a glassy fracture, it is quite impenetrable to the fluids of the mouth and stomach and exceedingly difficult to masticate. Soldiers whose back teeth are defective have difficulty in reducing the hard bread to proper condition for digestion; and to the soldier benumbed by cold or fatigue, imperfect nutrition is not unfrequently followed by protracted and dangerous diarrhoea.

THE MARCHING RATION.

Whatever weight may be attached to these considerations, there is one duty of the Commissary Department for which the existing arrangements are altogether inadequate. This is the duty of supplying *marching rations* for movements independent of base, such as forced marches, reconnoisances, raids, &c. Pending such movements, the chief in command orders the preparation of three, five, or eight days' rations. These are given out, cooked, packed in the haversack and knapsack, and laid aside to await expected orders to march. Meanwhile the daily rations are issued, cooked and eaten. A few days pass; the necessity, real or fancied, for the movement, has gone by, and the marching rations are found to be spoiled, and are thrown away. Or, if the march is undertaken

with the haversack and pack stuffed to unwieldy size and weight, the soldier soon feels obliged to abandon a part of his load; if he stops to rest, and leans back on his pack, his hard bread is crushed; if it rains, and the pack does not wholly shelter the rations, the powdered crackers, sugar, coffee, and meat become, together, an offensive mass and a *total loss*. Sometimes the salt beef and pork, though issued, are not taken by the men, and constitute a part of the aggregate loss. These losses in the army of the Potomac have been estimated by competent authority on the spot, from the organization of the army, to be little less than one third of the *total cost of the commissary supplies*.

SUPPLEMENTARY ARRANGEMENTS FOR THE COMFORT OF THE SOLDIER.

Certain provisions exist which enable the soldier to add to the variety of the ration, and otherwise promote his comfort. The company fund, which, if carefully managed, may amount to a very considerable sum in the course of a year, is chiefly derived from the excess of the army ration above what is consumed, and being in the nature of a present from the Government, is designed to enable the soldier to supply himself, under certain regulations, with particular articles he may need. From his pay he obtains of the sutler preserved milk, fresh pork, cheese, smoked beef, eggs, butter, sausages, tobacco, &c. In particular districts, the Government furnishes canned meats. They are largely supplied to the Navy, and replace salt meats and fresh beef in certain situations in the Army.

The desiccated vegetables furnished by the Government are serviceable in arresting tendencies to scorbutic disease, and in promoting and preserving the general health.

The bulk of these articles in the ordinary merchantable condition, and their liability to spontaneous decay with changes of atmospheric conditions, render their transportation as raw material to any considerable distance, quite out of the question. The

percentage of water is large. My determinations (Liebig's Annalen, 1846,) gave the following results :

	Percentage of water.
White Potatoes.....	74.95
Blue Potatoes	68.94
Red Beets.....	81.61
Rutabaga.....	82.25
Yellow French Beet.....	83.28
Carrots.....	86.10
Turnips.....	87.78
Onions	93.78

As desiccated vegetables, the water is in large part removed, the bulk correspondingly reduced, and the liability to injury from variations of heat and atmospheric moisture overcome. Potatoes, cabbages, turnips, carrots, parsnips, beets, tomatoes, onions, peas, beans, lentils, celery, &c., are thoroughly cleaned, sliced, dried in a current of heated air, weighed, seasoned, and pressed with the aid of a hydraulic press into compact forms, sealed in tin cases, and enclosed in wooden boxes. In this condition they are sent to the field. An ounce is a ration. A block one foot square and two inches thick weighs seven pounds, and contains vegetables for a single ration for 112 men. It requires only to be soaked in cold water, and then sufficiently boiled, with a piece of meat, to make a savory and every way delicious soup. If the meat be wanting, the vegetables may be served as soup without other ingredients. This ration is furnished in lieu of potatoes, rice, and peas or beans.

The proper officers may, within certain limits, vary the ingredients of the ration according to the tastes of the men and the facilities for procuring supplies.

POSSIBLE IMPROVEMENT.

In this view of the supplies of food for the Army, as now furnished, does science suggest any change looking to increased serviceability or increased economy ?

At first sight the chances seem to be against success in the attempt. The present ration has been shaped by a thousand exigencies, necessities, and suggestions ; is, in the main, a long-tried

ration, entitled to the respect due to a system thoroughly organized and worked out, and for these reasons it should not lightly be trifled with; but when we consider that the preservation of food, cooking, digestion, and starving are chemical processes, and that chemistry in its relations to life, even in the laboratories of scientific men, is of comparatively recent growth, and of still more recent application to practical affairs, there is an obvious possibility of success.

CAN THE BREAD BE IMPROVED?

The experience of the world has shown that unbolted meal is a healthier source of food than the superfine flour from which bran and groats have been separated in the process of bolting. The dark pumpernickel of Westphalia is eminently nutritious. It is made from unbolted rye meal. Black bread, which is the main item in the ration of the Prussian, Austrian, Bavarian, and Russian armies, is of similar origin. Crushed wheat has long stood in high repute as a material of food upon which men may be sustained under favorable circumstances indefinitely long. The Arab, in his protracted wanderings, with his hard, unleavened cake of wheaten, unbolted meal, illustrates the durability and serviceability of this form of farinaceous food. The Graham wafer is a type of the same article of diet. The southern soldier has its equivalent in his cake made of mixed wheat and corn meal; and the voyageur and trapper in their pounded parched corn.

Why should not the bread for the soldier be made exclusively from this unbolted meal?

The reason is plain. *Unbolted wheaten meal will not keep. It rapidly becomes sour at common temperatures.*

So long as the integument (the bran proper) of the wheat is unbroken, the interior, at ordinary temperatures and in a dry atmosphere, is kept from decay. The oxygen of the air is excluded. When, however, this pellicle is broken and the interior exposed to the air, decay commences. Oxygen is absorbed, fermentation instituted, and products offensive to the taste and smell result. The gluten, which is the primary agent in the fermentation, is disposed in a continuous envelope, constituting a sort of shell immediately

within the bran proper. Within this shell of gluten, the nitrogenous body of the wheat,—the reservoir of vegetable fibrine and albumen, and of the phosphates,—is a vast body of starch extending to the centre of the body and constituting from seventy to eighty per cent. of the whole grain. The following diagrams exhibit the relations of the different parts:*

Fig. 1.

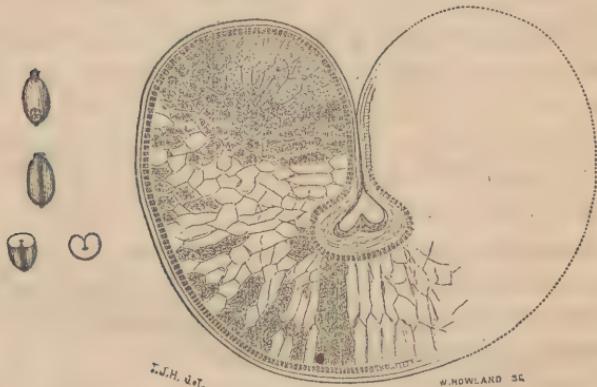


Fig. 1 exhibits the wheat grain or kernel of the natural size, presenting the grooved side and reverse and cross section; also, a cross section magnified to eighteen diameters, and displaying the bran coats, gluten coat, and starch cells.

Fig. 2.

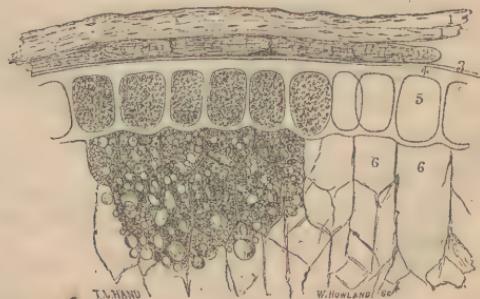


Fig. 2 presents a portion of a transverse section of white wheat magnified to one hundred and fifty diameters. 1, 1 are the coats

* I am indebted to Mr. Thomas J. Hand, of New York, for these original drawings.

of outer true bran; 2 is the inner coat of true bran; 3 is a thin filmy coat, covering the gluten cells; 4, cellulose containing gluten; 5, sacks of gluten; 6, starch cells.

The composition of wheat varies greatly with seasons and with manures. Barral, a French chemist, who has recently investigated this subject, finds the nutritive powers of equal weights of wheat differently grown to vary as widely as two to one.

The composition of wheat flour varies accordingly.

Gluten, including phosphates,	ranges from.....	10 — 20 per cent.
Starch.	.....	70 — 80 "
Sugar.	.....	3 — 8 "
Gum.....	.....	2 — 3 "
Water.....	.....	10 — 15 "

The starch is exceedingly hygroscopic. It absorbs moisture from the air with avidity. This moisture facilitates the changes which follow the absorption of oxygen. The consequence is a sort of fermentation, resulting in the breaking down of the gluten, by which its capacity for making and keeping bread light is impaired, or in consequence of which bread made from such flour is uniformly sour, heavy, unpalatable, and unsuited to digestion. In grinding, much of this gluten and the accompanying phosphates adhere to the bran proper and are separated with it; so that, according to Meyer, [Ann. d. chem. u Pharm. c i Bd. 2, p. 146,] a given weight of merchantable bran which he analyzed contained fourteen times as much of the phosphates as an equal weight of superfine flour separated from it by bolting. So large an amount of gluten being withdrawn, and the flour put up dry, it resists the influence of the atmosphere and may be preserved for long periods. But it is wanting in the gluten and phosphates.* Can this deficiency be supplied without interfering with the otherwise good qualities of the flour?

* Megè Mouriès (Compt. rendu, XLVIII, p. 431,) found the gluten coat to contain ten per cent. of nitrogen, [the index of the nutritive value,] while the average of the whole berry is from two to three per cent. Barral (Compt. rendu, I, 136, p. 834,) found the loss of nutritious material in the ordinary grinding and bolting nearly one half.

SELF RAISING FLOUR.

The supply of gluten may be regarded as sufficiently provided in the equivalent fibrine and albumen of the beef ration. The restoration of the phosphates has been accomplished in the method devised by me for making quick bread. The most important office of yeast is to furnish a source of carbonic acid in the interior of the loaf of dough. The introduction of ferment or sour dough, the setting of sponge, and the repeated kneadings have for their chief object the thorough incorporation of a source of carbonic acid within the mass of moistened flour. The yeast itself is a body in progress of decomposition, evolving carbonic acid. To the distension produced by the carbonic acid the lightness of the bread is due.

Now the evolution of carbonic acid may be effected by intimately incorporating bicarbonate of soda and pulverulent acid phosphate of lime with flour, and then mixing with water to a dough. The phosphoric acid combining with the soda releases the carbonic acid and so puffs up the mass. The phosphates in the form of neutral phosphate of lime and phosphate of soda lost with the bran are restored to the flour, and by the same act the bread made light and palatable.*

The prepared flour having substantial phosphoric acid, and its equivalent bicarbonate of soda, dry and finely pulverized, mixed with it, and to this mixture a quantity of salt added to suit the taste, is a *self-raising flour*, which, on the addition of water, may be stirred to a sticky dough and baked immediately. The halves of an old canteen constitute both bake-pan and oven; one half, containing the loaf of dough, is imbedded in hot ashes, and the other is inverted over it and covered with hot ashes. Such dough may even be wrapped in wet paper or leaves, and baked in the ashes.

This flour is but slightly injured when the barrels or bags containing it are rained on, since the water acts only on the surface of compact flour. With such flour, transportation of the bread

* See my pamphlet on The Theory and Art of Breadmaking, a new process, without ferment, published by Welch, Bigelow & Co., Printers to the University of Cambridge, 1861.

ration could be reduced to a minimum, both in bulk and weight. It does away with dependence on expensive ovens, does away with yeast, and makes possible and practicable fresh bread from the flour in half an hour. The various forms of biscuits, pancakes, fritters, duff, &c., may all be readily prepared from this flour where the cooking utensils are at hand. This flour may be carried in boxes, like hard bread, or in bags on the backs of mules, or in smaller parcels in the pack, and will serve for the bread of the marching ration in all cases where *fires may be permitted*.

IMPORTANCE OF FRESH LIGHT BREAD TO THE RAW RECRUIT.

The advantages of fresh, light bread to the health of raw recruits are well known. The medical officers of the Army of the Potomac remarked, on the Peninsular campaign, that the hard bread in many instances passed from the bowels without change. This was coincident with the frightful illness on the Chickahominy. The men immediately improved on the supply of fresh bread at Harrison's Landing.

The men who survive in health the exposure, irregularity, and to the majority, the frequently distasteful fare of the early campaigns, are the comparatively few who have a happy capacity of adaptation to varying external circumstances, and whose digestion is perfect at the outset. The rest are the men of more sensitive or less flexible organization, most of whom, once carried through the period of inuring, would in action display, in larger degree than their companions of ruder health, the *élan* so much valued in the French soldier. A regular supply, or a more frequent supply, of fresh bread in the first campaign would unquestionably save many to become *veterans*, who without it would be lost in the Invalid Corps, or to the country altogether.

Where fires, for any reason, may not be safely or conveniently made, as on special picket service, or on cavalry expeditions, or rapid movements generally, how shall the supply of bread, containing the whole nutrition of the wheat in the least bulk, be secured? The hard bread is deficient in gluten, in phosphates, in salt. It is scarcely baked; it is dried only. Is there any other resource?

BREAD FOR THE MARCHING RATION WITHOUT FIRE.

In the ordinary loaf, the crust, if thin and properly baked, is the part most relished. It differs from the interior in having been exposed to radiant heat, which has converted its starch into dextrine and roasted its gluten. These changes, carried only to the verge of destructive distillation, leave the gluten substantially unimpaired, and the taste improved by the production of a trace of essential oil. The crust contains none of the thirty-five to fifty per cent. of water which belongs to the baker's loaf. Indeed, it contains some twelve to fifteen per cent. less than the flour; so that weight-for-weight, good, *not bitter*, crust is about twice as nutritious as the crumb of bread. Barral found it, in some samples, two and a half times as nutritious.

Now, is it possible and practicable to apply this hint to the improvement of the bread ration? It is wholly practicable, and has already been done.

The mountaineer of Chili, when prepared for an extended journey, takes, as his sole reliance for food, *roasted and ground wheat*. When he feels hungry, he stirs some of this powdered grain into cold water and drinks it. If opportunity offers, he varies his diet with such articles of food as may present themselves; but he is independent of them, and travels for weeks together, depending upon this single source of nutrition.

The Texan Ranger, for long expeditions, uses what is called *cold flour*, consisting of roasted or parched corn, ground, and mixed with sugar. The voyageurs of Lake Superior, and the trappers going out from that region, take roasted and ground corn, incorporated with melted fat.

This roasted wheat has all the gluten and phosphates normal to the grain. The addition of a trifle of salt renders it palatable, and gives to the organism its needed quantity of this condiment.

This form of farinaceous food is of early use. Count Rumford recognized the excellent effect of roasting grains or the bread made from them. It makes the food more palatable and more soluble.

The Athenians used roasted barley. The ancient Scots, in their forays into England, carried oatmeal as their only article of food, which they mixed with water and baked on iron plates, making a sort of hoe-cake. In the East, a sort of thin roasted cake, of unbolted meal, has been used from time immemorial. The armies relied upon roasted farinaceous food.* Parched corn was a dish which Ruth shared at the table of her future husband.

This preparation of roasted and ground wheat meets the want of the marching ration, where it is desired to move rapidly and dispense with impediments to the last degree. Few articles require less preparation. The soldier may roast it himself. Nothing is more certain than its quality of preservation. No food is more concentrated, or requires less for transportation. It may be found in almost every agricultural district, in quantity sufficient for immediate wants. Freshly prepared, it fulfils in good degree the office of a beverage, at the same time that it meets the demand for bread.† Roasted rye, though less agreeable, might be substituted for wheat where the former is abundant and the latter wanting. Roasted barley and parched corn have already been mentioned. Peas have been ground to fine meal, cooked by steam, kiln-dried, and used as an article of diet. Experience would doubtless show that, in some situations, other grains might be profitably roasted and employed as food.

The quantities of different grains and articles of food, in dried condition, which are the equivalent in nutritive value of 100 parts

* In some recent articles in the "National Intelligencer" upon the subsistence of ancient armies, the editor, in presenting the fruits of no small measure of research, has enabled us to comprehend how Xerxes maintained his vast army. He caused immense accumulations of corn to be made, extending through several years, and when his troops moved he provided bakers to accompany them. The supply of meat was relatively small. The chief article of diet must have been roasted cakes made from the unbolted meal of cereals.

† The essential oil of roasted wheat, like the essential oil of roasted coffee or parched corn, exerts an important influence in retarding the metamorphosis of tissues—preserving the muscular fibre, and so reducing the quantity of food required for health. This substance which is the basis of the agreeable flavor, and the sweetness also acquired by roasting, may enable the roasted wheat in emergencies to supply the place of both the coffee and sugar.

of wheat, are, according to my nitrogen determinations, as follows :*

Lentils.....	55.5	Wheat.....	100.0
Peas.....	58.8	Barley.....	104.0
Beans.....	59.0	Corn.....	115.0
Oats without hulls.....	78.0	Buckwheat.....	170.0
Rye.....	98.8	Rice.....	220.0

MEAT FOR THE MARCHING RATION.

We have already seen the great loss arising from the attempt to provide meat for the marching ration, from the existing stores of the Commissary Department. The fresh meat, especially in warm weather, however well cooked, in the course of a day or two becomes unpalatable and worthless. Salt beef, as well as fresh, is bulky and heavy from the large percentage of water and inedible substance entering into its composition. It occasions great thirst. Salt pork, though for some reasons greatly to be preferred to salt beef, greases everything with which it comes in contact, and sustains a loss of some three fourths when broiled on a stick, as it usually is on the march.

Fresh beef as a source of the marching ration has some advantages. It carries itself. The cattle can be driven; but this advantage is limited. Of what use are live cattle on such an expedition as Averill's, to cut the Virginia and Tennessee Railroad; or Kilpatrick's, in the rear of Lee's army, threatening Richmond? In a forced march the herd of cattle must be some distance in the rear, and the supply of fresh beef irregular. The best of cattle in Ohio, Indiana, or Illinois, after transportation in cars; with little water, food, or sleep, during several days and nights of continuous travel, and after being driven about, for two or three weeks, with scanty forage, or none at all, furnish as a whole, meagre and inferior beef. To preserve the beef the cattle are slaughtered, in summer, early in the morning, and the meat immediately boiled, if conveniences will permit, to prevent its becoming fly-blown. The juices extracted in this boiling are uniformly and necessarily lost. The edible

* Liebig's Ann. der Chem. und Phar., 1846.

meat is much of it lost in the difficulty and haste of detaching it from the bones. It has no provision against spontaneous decay. It is not always at command when most needed; it is bulky, and yet the actual edible meat, which the soldier derives from an ox slaughtered on the march, is much less than is ordinarily supposed. The advantage of providing it on the hoof is correspondingly small.

In slaughtering, the weight is diminished by loss of blood, the removal of the tongue, heart, and liver, the viscera and offal, and legs to the knee. This reduction, called shrinkage, in good cattle fresh from the pasture, amounts to at least one third. An ox in fair condition weighing 1,500 pounds on the hoof, would lose by shrinkage 500 pounds.* The intestinal tallow would weigh 100 pounds more, the head and hide 100 pounds more, and the kidney tallow and lump fat 50 pounds more. Altogether, the dressed quarters without the kidney tallow and lump fat, weigh but half the ox on foot. But the bones, gristle, tendon, connective tissue, and loss of meat in the sinuosities of the back bone and along the ribs, reduce the edible portion to the *consumer* to three fifths of the weight of the dressed quarters, or three tenths of the weight of the whole ox. Of this three tenths, seventy-five per cent. is water.†

So that an ox weighing 1,500 pounds yields to the consumer, as ordinarily served up, but about 450 pounds of edible meat with its water, or but one quarter of this, or three fortieths of the whole, of dry nutritious matter, or $112\frac{1}{2}$ pounds, or 6.8 per cent, of the whole weight of the live ox.

* Lawes and Gilbert found (*Phil. Trans.*, 1859,) the average shrinkage of 16 fat cattle, consisting of 2 heifers and 14 bullocks, and ranging from 816 lbs. to 1,652 lbs., on the hoof, to be 40 $\frac{1}{2}$ per cent.

† The percentage of water in fresh meats, compared with milk, are as follows:

Milk.....	87.0	Veal.....	75.0
Fish.....	80.0	Mutton.....	74.0
Muscle of Pork.....	77.0	Chicken.....	71.0
Beef.....	75.0	Tendon.....	30.0

Lawes and Gilbert found the flesh and fat together of a *half fat* ox to yield 24.82 per cent. of dry meat, while that of a *fat* ox gave only 18.71 per cent.

In a practical experiment, which came to my knowledge as having recently been made in New York, with an ox weighing 1,200 pounds dressed, and of course some 1,800 pounds on foot, there were found 400 pounds of edible meat, which yielded when dried to fibre some 112 pounds, a quantity amounting to 6.22 per cent. of the live ox. Small as this seems, the cattle in the train of an army on the march, yield a much less return. The army rule in regard to beef-cattle is, that when the cattle weigh over 1,300 pounds on the hoof, 45 per cent. shall be deducted for shrinkage; when below 1,300 pounds, 50 per cent. The fat, it would seem, is assumed to have totally disappeared. But much more has, in reality, disappeared. From the statement of commissary officers having charge of the commissary supplies of some of the regiments of the Potomac army from its commencement, it appears that it requires about one ox and a half to furnish the fresh beef ration to a regiment of 225 men—or about six oxen to 1,000 men. This meat was issued as dressed quarters, which were weighed. So that twenty-four quarters of beef-cattle in the condition in which they are slaughtered in that army, weigh on an average 20,000 ounces, or 1,250 pounds. Assuming the bone, tendon, and gristle to be three fourths of the whole dressed quarters, which is not far from the fact, there would remain $31\frac{1}{2}$ pounds of edible meat, or 52 pounds to an ox; of which one quarter only is dry nutriment, or 13 pounds to an ox. And this is an average specimen estimated by the commissary officers from whom I have received the information, to have weighed when purchased by the Government, 1,300 pounds, on the hoof. Six of these must have weighed 7,800 pounds and would cost now, delivered at eight cents a pound, \$624! *Seventy-eight pounds out of seventy-eight hundred! One per cent. only!*

Neither hide, bones, or tallow of any kind, as a general rule, is saved on the march. In a word the dry edible fresh beef derived from cattle on the hoof according to this estimate, costs the Government \$8 a pound, or with the three pounds of water \$2 a pound, or with the bone, tendon, and gristle 50 cents a pound. But a reduction so great cannot be presumed to be uniform in the Army of the Potomac, though it is known that during the last two winters the cattle got little or no forage from the time they

were sent down by boat and the cars to Falmouth, and by cars to Brandy Station, till they were slaughtered. At Hilton Head the loss in flesh was less. At Chattanooga it was greater. Col. Eaton, in charge of the subsistence department at the post of New York, has informed me that the army ration of fresh beef at Hilton Head cost the Government 30 cents, at a time when canned meats of perfect quality, cost, delivered, but 16 cents a pound. Eight ounces of good canned meat may be assumed to be a full equivalent for the fresh beef ration with its bone, tendon, and gristle, as supplied to the individual soldier at Hilton Head. At the present prices of canned meats, of say 24 cents a pound, delivered, the ration of fresh beef at Hilton Head must cost the Government 45 cents. A pound must cost 36 cents, bone, tendon, and gristle included. The edible meat would therefore cost some three to four times as much, say \$1.25 per pound, and with its water eliminated, \$5 per pound.

A medical officer, whose duties called him to Chattanooga, during the months preceding the battle of Lookout Mountain, has informed me that the cattle furnished to that post were so sick and exhausted from the effects of the transportation from Louisville, and so reduced and emaciated from having had absolutely nothing to eat on the railroad and after their arrival, *for weeks* in succession, that some of them reeled in walking, and falling or lying down were unable to rise. It is true that the bullocks that thus fell were not eaten, but they indicate the condition of those which had been subjected to the same suffering and deprivations and were actually used as food. What these cattle on the hoof cost the Government I know not, but probably not less than the cattle supplied to the Army of the Potomac, while their value for food must have been less and the cost of the ration of fresh beef correspondingly greater.

It appeared in evidence before the Crimean Sanitary Commission that the cattle supplied to the English army were so reduced by the hardships of the voyage and little or no forage, after landing, as in many cases to be scarcely more than skin and bone. Much of the meat was so tough, that although called beef, it could not be eaten and was rejected by the men.

Now, this enormous expense—enormous if we reduce the estimate by a whole quarter, or even a third—is incurred by Government, and this fearful sacrifice of cattle made by the country, to provide indifferent and frequently deleterious fresh meat, in scanty quantity at the best, for the soldier in active service.

DOES SCIENCE SUGGEST ANY ALLEVIATION ?

The Government wishes a light marching ration of fresh meat. It wants it cooked, seasoned, made thoroughly palatable to the soldier, and capable of preservation indefinitely long. *Where* it is made light by being relieved of its surplus water, bone, tendon, gristle, lump fat, &c., is of no moment. *How* it is endowed with antiseptic qualities is not material, provided they are healthful. It is not necessary that this ration be prepared in camp. It may be prepared wherever it is convenient to collect numbers of fat cattle.

To facilitate the transportation of the marching ration, it is desirable that the bulk and weight be reduced to the lowest practicable limit, and the food made imperishable. The great enemy to preservation is water. It facilitates the molecular interchange upon which decay depends. The water beyond the limits of ready preservation must be expelled. The dried buffalo meat of the Indians on the Western prairies, common jerked beef and venison, pemmican, Appert's dried meats, and the desiccated meats now prepared for long voyages, are illustrations of the protection against decomposition which the removal of the water secures. But the drying should not be carried beyond the point which permits the ready restoration of the juices of the meat in savory condition. This may be done at temperatures from 110° to 125° Fah. To insure its preservation, if not dried, the oxygen of the air should be excluded from it. Cans are, on many accounts suited to this purpose. Perhaps the only objection to them is that they are liable to injury in long or hurried transportation, and the puncture of a can, however slight, especially where the water has not been materially diminished, is quite sure to be followed with deterioration of the meat.

What expedient is there which fulfils all these requisitions ? They are all fulfilled by putting the meat in the form of

SAUSAGE.

The German has reduced this manufacture to its simplest elements. He makes sausage from every edible part of the animal, including the liver and even the blood. The cleaned intestine is his costless but perfect can. Smoke, heat, dry air, salt, and fragrant herbs and spices are his antiseptics.

The healthfulness of the sausage, its quality as a relish, the variety of forms in which it may be served, and its antiseptic qualities, combine to commend it for the soldier's marching ration of meat. It is well known that when the soldier gets his pay, he repairs at once, if in camp, to the sutler to purchase sausages, and continues to enrich his fare from this source so long as his money lasts. In some regiments, no pork has been drawn for a month after pay-day.

Can the sausage system be carried so far as to include the dressed carcass of the whole ox ?

Let us suppose a supply of live cattle in their individual best condition—in Illinois, for example—and an establishment on an adequate scale, for economizing the nutritive value of the animals to be slaughtered. There should be mincing contrivances, facilities for boiling by steam, baking or roasting, digesters, evaporating pans, drying apartments, hot air, smoke, pyroligneous acid, gelatine, bisulphite of lime, &c.

The mincing apparatus would reduce the meat to fineness ; the steam or baking apparatus would boil, or bake, or roast it ; currents of heated air would dry it ; evaporating pans might perform the same office, at temperatures so low as to preserve in palatable form all the juices of the meat ; and Papin's digesters would resolve a large part of what is now utterly lost on the march—soft bone, gristle, tendon and connective tissue, into most nutritious food, to be incorporated with the minced meat or used as stock for soup. The different kinds of meat, and the tongue, heart, brain, and concentrated soup stock might, for particular purposes, if desirable, be disposed in different sausages. But for army use, the whole might be resolved into homogeneous sausaged meat.

The deficiency in sausage-cases might be supplied by sewing cotton or linen into tubes, overlapping the seams, or weaving or knitting tubes, like hose, dipping them in gelatine, and if necessary afterward, in tannin, to make a leathern sheath. Or the dried sausage material, cooked by steam, or less dried and roasted, might be compressed into cakes, and varnished with gelatine derived from scraps of the hides.

The efficiency of dry air in removing the water, of the creosote, of smoke and pyroligneous acid in coagulating the albumen and forming an impermeable and quite insoluble envelope, of a varnish of gelatine and solution of tannin, in making leather, are well known. The bisulphite of lime would also coagulate the albumen, and besides arrest the oxygen of the air that would otherwise produce decomposition. I have preserved beef perfectly fresh for a period of seven years by sprinkling it with dry powdered sulphite of lime, packing it in glass vessels, and covering with a stopper of plaster of paris. At the end of this period, the beef was as fresh and bright as when it was laid down. The intestine should be saturated with a solution of the bisulphite, and then thoroughly rinsed, before using.

The drying of the sausage material could be carried, after cooking, to the limit which would allow the juices readily to dissolve on the addition of water, then seasoned, and then stuffed into the prepared intestine, or cotton or linen-leather case, or pressed into forms and varnished as stated above.

Such sausage might be fried or made to contribute to a stew, the great resort in camp, or hash with bread-crumbs or roasted wheat and water, or a soup with vegetables, when these may be procured. The only cooking utensil absolutely needed would be the half of an old regulation canteen, or even a drinking-cup. A simple device suited to this want will be described further on. In the absence of fires, the sausages already cooked may be eaten plain.

The establishment which prepares sausages for the field might also prepare Liebig's juice of beef, for hospital use. Professor Gibbs, of Harvard University, and connected with the Sanitary Commission, from its organization has proposed, as the result of

practical research, to concentrate this extract in vacuo and preserve it, and also concentrated preparations of soup stock, for hospital use, with the aid of sulphite of soda. It may be practicable to secure lard, or stearine, or tried fat of beef, or even butter, in intestinal leather. This would meet the demand for butter or oil, so great in camp, but hitherto regarded as a hopeless impossibility to satisfy. The opening of such establishments in cattle-growing districts, under scientific direction and governmental supervision, could not fail to lead to many applications of the principles here laid down. Mr. Borden's long-continued labors in this field, crowned with distinguished success, are proof of the practicability of the general plan.

THE MARCHING RATION.

Assuming these suggestions to be carried out, the marching ration might consist of *roasted wheat and sausaged beef*. Of these, each corps or division might have a stock on hand, to be drawn from whenever the order to march came. Of this marching ration there would be nothing to spoil, nothing to injure by the rough handling of the pack, nothing to waste. To the last morsel, the roasted wheat and sausage may be eaten. There would be no longer the preparation every few days of the ration of boiled beef, or raw pork and hard bread, only to become unpalatable and then thrown away. There would be no waste of strength in transportation, since the weight and bulk of the ration would have been reduced to a minimum, and the articles of diet admit of being packed with the least waste of space. Of this ration, a soldier might carry enough to sustain him in fighting condition for twelve days. In an emergency with the chances of occasional foraging, the time might be extended to twenty days.

If instead of *roasted wheat* the soldier took *self-raising flour*, it would occupy but three eighths of the space of hard bread, and the weight need not be more than 8 ounces of roasted wheat, or 11 ounces of self-raising flour. Of the dry sausaged beef, a daily ration need not weigh more than 3 ounces. The whole ration, taking a part of self-raising flour and a part of roasted wheat, with the sausage, and a large coffee ration, need not exceed one pound, in

place of the present ration of two pounds or two and a half pounds, a reduction in weight of from one half to three fifths.*

The soldier now, in emergency, carries three days' rations in his haversack and five in his knapsack. If full rations, they weigh 16 or 20 pounds. But great as the weight is, the bulk is still more objectionable. Eight days' rations of hard bread packed without crushing, occupy a space of more than 500 cubic inches. The fresh or salt beef would occupy 300 cubic inches, or the salt pork 180; the coffee and sugar about 30; altogether the eight days' rations would fill 830 or 786 cubic inches. This great volume makes the haversack and pack unwieldly, and it is not to be wondered that so much of the food is thrown away, or that the total actual loss in the marching rations is so enormous. But the proposed ration weighing but about three eighths or with the coffee ration only one half, is in bulk less than one third. The self-raising flour at three eighths of the hard bread, or 188 cubic inches; the sausaged beef at, say 4 cubic inches for each ration, or 32 cubic inches in all, and the coffee and sugar at 30 cubic inches, amount to 250 cubic inches. With the sausage rolled in the blanket, the coffee and sugar in one bag, and the self-raising flour or roasted wheat in another, the ration suffers no injury from pressure of the pack, or from the rain; avoids the chances of loss, and provides palatable food to the end of the expedition. With the aid of mules carrying self-raising flour or roasted wheat and sausaged beef in bulk, it is not difficult to see that an army of one hundred thousand men might swing around from one base of supplies to another, with an interval of thirty or even forty days between.

THE STATED RATION.

For the stated ration at the base of supplies or where there is direct and safe communication with it, the self-raising flour offers the comfort of warm fresh bread, perfectly healthful though warm, and more healthful than the hard bread or average stale yeast bread, of ordinary camp supplies, and with the warm bread, a great variety of forms of farinaceous diet. The sausaged beef affords an agreeable variety, whether served plain or as a fry or stew. The

* Captain Sir Edward Parry estimates the food necessary for men in the Arctic regions to be: flour, 10 ounces; edible meat, 9 ounces; cocoa, 1 ounce.

liquified bone and tendon, with or without the desiccated vegetables constitute a stock for soup. For hospital purposes beside the bouillon or juice of the beef and the soup just named, delicate bits of tender meat from the line of the back bone, not accessible to the knife, but easily detached after steaming, may be especially prepared for convalescents.

COFFEE.

The coffee as now supplied to the army, burned and ground, is treated, in a large way, with boiling water and served by the pailful. The individual soldier prepares it, if necessary, in his cup. There is little exception to be taken to the supply of this constituent of the ration. It might be lessened in bulk and weight by making an extract and concentrating it at low temperature in *vacuo* with milk and sugar, the whole being reduced to a paste and put up in the cotton-leather tubes already mentioned. Such a preparation would possess within itself, antiseptic qualities of a high order. A teaspoonful of the paste stirred with hot water would make excellent coffee. If used as a constituent of the marching ration it might be served with cold water. This preparation would add the cost of milk and some labor to the present expense of the coffee ration, but it is possible, nevertheless, that its convenience for the marching ration and its economy in transportation would more than counterbalance the increased expense.

Cocoa is used in the British service with eminent satisfaction to the men and medical officers. In the absence of coffee, an acceptable drink may be prepared by infusing freshly roasted ripe corn, or barley, or peas, or wheat.

TOBACCO.

The experience of camp life has shown conclusively that there is an article contributing greatly to the comfort of the soldier, of which no note is taken in the Government ration. This article is tobacco. It is the universal testimony of officers, chaplains, and especially of the rank and file, that the cheerfulness, good spirits and even general health of the men are greatly promoted by the temperate indulgence of the taste for tobacco. Soldiers

caring little for the cigar at home, on furlough, find it indispensable on their return to camp. Some among them say that a five minutes rest *and smoke*, when on the march, " puts them in wind ;" while the five minutes rest *without the smoke* leaves them fagged and without renewed elasticity. Others, that it renders them oblivious of discomforts ; others, that they are less thirsty on the march ; others, that it gives them " pluck." It unquestionably exerts, in some degree, antiseptic effects through the action of the carbo-hydrogen essential oils, produced by destructive distillation in smoking, as the essential oil of coffee does. Whether the use of the pipe, or cigar, or chewing tobacco after a meal, by awakening the salivary glands and with them the general secretory apparatus of the alimentary canal, so promotes digestion, or whether the effect be more immediately upon the nervous system, or whatever its strictly physiological effects may be, it cannot be doubted, that as a matter of fact and Government concern, some mode of rendering tobacco more easily accessible, would be a great boon to the soldier. In 1853 the French Emperor decreed a daily ration to each soldier of one third of an ounce of smoking tobacco.

THE IMPROVEMENT OF THE ARMY RATION.

The problem of improving the ration of the soldier is, primarily, one of humanity, and secondarily, one of dollars and cents, and practically resolves itself into—

How to lessen the present expenditure in the subsistence department while maintaining or increasing the health, comfort, and efficiency of the soldier.

THE BREAD RATION.

That the economy of the present mode of supplying the bread ration, and the excellence of the ration itself admit of improvement, may be easily shown.

Let us assume, for the convenience of an estimate, that the distance from the point of delivery of supplies to an army of one hundred thousand men is such that the cost of transportation by wagon, everything included, of a barrel of flour is one dollar.

Taking the observations made at the Capitol bakery, Washington, that one wagon would carry as much flour as would load seven wagons with fresh light yeast bread, there would obviously be an enormous gain in transporting flour rather than bread. But when the Government sends loaf bread, it consumes scarcely two thirds, say 14 ounces, of the flour to which the soldier is entitled, the remainder being water.*

The Government sends daily, to feed the army of 100,000 men, 1,400,000 ounces of flour in the form of bread, weighing, in round numbers, 2,200,000 ounces. The soldiers are entitled to receive 2,200,000 ounces of flour, or 800,000 ounces more than is sent them in the loaf. The army therefore loses 800,000 ounces, or 223.4 barrels of flour daily, or 81,395 barrels annually, amounting, at \$8 per barrel, to \$651,160. The transportation of 1,400,000 ounces, or 442.4 barrels of flour daily, would cost for the year, \$162,790. The transportation of the bread, on the other hand, made from this flour, would cost seven times as much, or \$1,139,430. Deduct the cost of carrying the flour, \$162,790, and we have \$976,640 as the extra cost of transportation.

But, this is not the whole loss. Where the ration of bread in the loaf is issued once in four days, as it has been to the army of the Potomac at Brandy Station during the past winter, sent from the Government bakeries at Alexandria—a distance of 56 miles by rail, and several miles further by wagons—it becomes so dry and hard, lying in the tent, that the new ration finds one quarter of the previous issue unconsumed. Here is a quarter of the 14 ounces of flour to each soldier lost, in addition to the previous 8 ounces, but which might have been saved if the bread had been eaten when freshly baked. Applying this fact to our supposed case of 100,000 men, we have a loss of 3.5 ounces daily to each soldier, or 350,000 ounces or 97.7 barrels daily to the whole army, or 35,610 barrels annually, which, at a cost of \$8 per barrel, amounts to \$284,880. The transportation in the form of bread, at seven times the cost of transportation as flour, amounts to \$259,270.

* Barral found the water to vary in thirty-six samples from 31.19 to 46.9 per cent., an average of 39.04 per cent. Dr. J. F. Watson (Lawes and Gilbert, Phil. Trans., 1850,) found the average of forty-three loaves to be 36.37 per cent.

The several sums, consisting of the

Loss in flour.....	\$651,160
Do.	284,880
Loss in transportation.....	976,640
Do. do.	259,270
Amount to.....	\$2,171,950

If we assume the self-raising ingredients to cost a dollar and a quarter for each barrel of flour, and the flour required, to be in accordance with the foregoing facts, but 11 ounces to each man daily, or 111.908 barrels for the whole year to the army of 100,000 men, the total cost of self-raising ingredients will be \$139,997, which, deducted from the above estimated loss, gives a net loss of \$2,031,953.

ROASTED WHEAT.

Let us estimate the saving in the use of roasted wheat, as compared with the use of flour, hard bread, soft bread, and self-raising flour. A barrel of flour, weighing 196 pounds and costing \$8, requires for its production about $4\frac{1}{2}$ bushels of wheat, weighing 270 pounds. Roasted, it weighs about 20 per cent. less, or 216 pounds, or 3,456 ounces. At 8 ounces to a ration of roasted wheat, we should have, from the wheat which will produce one barrel of flour—

142.5 rations of flour, at.....	22 ounces each.
176 do. hard bread, at.....	17.5* do.
224 do. soft bread, at.....	14 do.
285 do. self-raised bread, at.....	11 do.
432 do. roasted wheat, at.....	7.2 do.

An army of 100,000 men would consume, in a year, of the ration

Of 22 oz., 256,058 bbls. flour, costing, at \$8 per bbl., \$2,048,464	
17.5 do. 197,863 do. do. do.	1,582,904
14 do. 162,946 do. do. do.	1,303,568
11 do. 128,029 do. do. do.	1,024,232
7.2 do. 83,800 do. do. do.	670,400

* The flour, in being resolved into hard bread, loses about 10 per cent. of its water.

The saving, by using the roasted wheat, over the hard bread and flour ration, leaving out of account the cost of the preparation of the hard bread and roasted wheat, is—

	In cost to the Gov't.
Over hard bread ration.....	\$912,504.
Flour do.	1,378,064.

If we add a dollar a barrel for transportation from the base of supplies, for extra transportation of flour and hard bread, (the barrel of which weighs but 75 pounds,) we shall have—

For saving in transportation over hard bread.....	\$472,156
do. do. with flour.....	172,258

Adding this to the loss above we shall have—

For total saving of roasted wheat over hard bread,....	\$1,384,660
do. do. flour.....	1,550,322

Taking the average saving of these three modifications of the bread ration we have \$1,655,645.

THE MEAT RATION.

I do not propose to consider the question of a possible substitute for salt pork and salt beef. The supply of these articles to the army must continue, for the reason that they possess certain important qualities suiting them to the practical requirements of the Government. They will keep in bulk, and may be purchased, like flour, in quantity, at rates but little fluctuating, in all parts of the country. Moreover, the greater proportion of the rank and file of our armies are accustomed to them as articles of diet. Let us look at the considerations in favor of the supply of fresh beef in the form of sausaged meat.*

* The increasing relish for salt pork over salt beef in our armies has already been alluded to. The experience of the French soldier shows the large relative demand for fresh beef. The total consumption of meats by the French army in the Crimea was about in the following proportions, taking 8 ounces of canned meat to be the edible equivalent of 20 ounces of fresh beef, including bone, tendon, gristle, &c., such as is usually supplied to marching troops:

Salt beef.	Salt pork.	Fresh beef.
1 : :	10	20

For convenience in forming an estimate, let it be required to provide an army of 100,000 men, situated as the Army of the Potomac may be expected to be during the coming campaign, with fresh beef on alternate days. Let us further assume that the cattle are drawn from the State of Illinois, or Ohio, or Indiana, and that the cattle on the hoof, in their native pastures, weigh 1,200 to 1,800 pounds, or on an average 1,500 pounds each.

The problem may be thus stated: How can the nutriment existing in an ox weighing 1,500 pounds in Illinois, be best supplied to the Army of the Potomac?

Good cattle vary much in the relative proportions of flesh, bone, gristle, tallow, and volume of viscera, as well as in size, and more still in the hardships and deprivation of food to which the exigencies of the service may subject them; but from inquiries of drovers, butchers, persons engaged in preserving, curing, packing, and selling meats, and of commissary officers in active service, the following statements may be regarded as trustworthy.

The ox may be sent by rail to Washington, incurring the hazard of the closely packed car, with little rest, or water, or food, or sleep, for the entire trip of several days and nights, and, on his arrival at Washington or soon after, driven about in the train of the army, with but scanty forage—at the best a starving, sick ox, till consigned to the butcher; or, the ox may be brought to New York or Boston, consuming six or eight days and nights from the pastures in Illinois, feeding at Niagara Falls and at Albany, and losing, say only 100 pounds* of the dressed carcass, and the edible portion put up at its normal weight, without drying, as cooked meat in cans, with one tenth of fat added.

Or the ox may be slaughtered fresh from the pastures in Illinois without any of the deterioration or hazards of long transportation, the total edible meat cooked, reduced to one third of its weight by removing the water at low temperature and so retaining its juices in concentrated form, and put up in condition to be preserved; the soft bones, tendon, and gristle, being reduced to an emulsion by steam under pressure and dried to the condition necessary for admixture with the sausaged beef proper.

* Estimates uniformly place the loss at 200 pounds.

By the first method, the cattle are so reduced by deprivations and hardships that the intestinal tallow disappears, and with it most of the kidney tallow and lump fat, the muscles shrink, the tendon and gristle relatively augment, and there is such general deterioration that, applying the observation by commissary officers in some of the brigades of the Army of the Potomac made upon cattle estimated to weigh, in good condition, 1,300 pounds on the hoof, as already shown, to cattle weighing 1,500 pounds, the four dressed quarters would weigh but 240 pounds; of this, 60 pounds only, are actually consumed by the soldier. If this be below the average for the Army of the Potomac, it is certainly above the average for the Army at Chattanooga, and if there be something in favor of the greater weight, because larger cattle are frequently better cattle, it is probably much more than balanced by the losses by sickness, casualties of transportation, and other deteriorating causes, not especially referred to in this estimate. The tallow, as already remarked, is wanting; the hide is lost on the march; no use is made of the bones, marrow, tendon, or gristle, the juice of meat that is boiled is lost; and altogether it may be safely assumed that if, in individual cases, the yield is sometimes larger, the actual meat eaten by the soldier is not under estimated.

By the second method, as a consequence of the exhaustion of the long ride and fasting, the ox loses say only 100 pounds of the body and juices of the meat, reducing by so much the weight of the dressed quarters. Of the dressed quarters, two thirds, including one tenth fat, might be canned. Giving 33 per cent. to shrinkage, 100 pounds to head and hide, 100 pounds to intestinal tallow, and 50 pounds to kidney tallow and lump fat, there would remain 684 pounds. Of this, two thirds are 456 pounds.

By the third method, without transportation, and the loss of the substance and juices of the meat which it occasions; without the losses by sickness or accident by railway, the dressed quarters, without the kidney tallow, would weigh 784 pounds; and as it would be safe to assume at the least, 16 pounds less shrinkage than in the case of transportation in the cars, on the hoof, to Boston, this would give a round 800 pounds for the weight of the dressed quarters.

Of these 800 pounds, two thirds may be claimed as edible, including the heart, tongue, and brain, together with the intermuscular but not lump fat. Besides these 533 pounds of strictly edible meat, the remainder of 267 pounds of bone, gristle, tendon, and connective tissue—with a primary digestion in water at 212°, and a secondary treatment of the soft bones, tendon, and gristle, with water at higher temperature, preparatory to incorporation with the great body of the meat—may be assumed to have a nutritive value of, at the least, 167 pounds, making 700 pounds in all. These 700 pounds may be cooked, reduced to one third of their weight, or $233\frac{1}{3}$ pounds, and put up, seasoned and compressed in sausage form, or as cylinders, or cakes varnished with gelatine, for convenient transportation and ready use. It may be desirable to reduce the weight of some of the forms of cooked meat, as the roasted for example, somewhat less.*

By the first method, the ox on the hoof at 8 cents a pound, and weighing at Washington 1,400 pounds, costs \$112.00, and yields 60 pounds of edible meat at \$1.86.6 per pound.

By the second method, there are 450 pounds of canned meats, put up at Boston, at 23 cents a pound and costing, \$103.50; for transportation to the army, say \$4.50. Total, \$108.00; making 450 pounds at 24 cents a pound.

By the third method, the live ox of 1,500 pounds weight, at 6 cents a pound in Illinois would cost \$90.00; assume the cost of dressing, cooking, curing, and packing at \$14.00. Total, \$104.00; to be reduced by the value of the hide and tallow, say \$16.00. For transportation of the sausaged meat of the entire ox an equivalent of 700 pounds of edible meat reduced in weight to one third, say \$3.00; a net cost of \$91.00; making 700 pounds at 13 cents a pound.

Placing these results side by side, the Illinois ox of 1,500 pounds weight on foot, would yield by the first method 60 pounds at \$1.86.6 a pound; total, \$112.00. By the second method, 450

* The pemmican put up for Sir John Richardson's boat voyage through Rupert's Land, was made from rounds of lean beef, dried to one fourth of its weight, ground and mixed with an equal weight of beef suet or lard. A proportion of it was mixed with Zante currants and another proportion with sugar.

pounds at 24 cents a pound ; total, \$108.00. By the third method, 700 pounds at 13 cents a pound ; total, \$91.00.

One hundred dollars would deliver—

By the first method	53½ pounds.
“ second “	416½ “
“ third “	769 “

To supply 100,000 men with alternate daily rations of 5 ounces of edible meat* for a year, (the Potomac Army are supplied with fresh beef 4 days in the week,) would cost—

By the first method.....	\$11,136,328
“ second “	1,425,781
“ third “	741,406

The saving to the Government by the adoption of the second method would be \$9,710,547 ; of the third method would be \$10,394,922.

For a smaller number of men, or for a less time, or for points of easier access, the loss would be correspondingly less. Upon the basis of the cost of the fresh beef ration at Hilton Head, the loss would be \$6,496,826. But for an army less favorably situated, if the edible meat of the ration be increased to eight or ten ounces instead of five, the expense would be greater. Admitting the data to be in the main correct, and the future will probably show that they cannot vary far from the truth, there seems no way of escaping the conviction of an appalling loss in prospect by the present system of supplying the fresh beef ration.

LOSS OF THE MARCHING RATION.

Assuming the present daily ration to cost but 24 cents, the loss of one third as already mentioned, amounts for 100,000 men at 8 cents daily to \$8,000 ; for 365 days, to \$2,920,000. But the ration will cost much more. There were times before the war when it was as low as 8 cents. During the first year of the war it was some 16 cents. Last year it was about 22 cents for some of the armies. For the coming year it will not probably be less than 36 cents.

* This is the estimated quantity which the 20 ounces of poor meat with its bone, tendon, gristle, &c., actually yields to the soldier.

This would increase the amount to \$4,380,000.

But this is independent of many of the expenses of transportation. Taking into account the building of roads, the repairs of railroads, the renewing of bridges, purchase of locomotives and trains, steamboats and fuel, losses of steamboats, losses by accident, capture, deterioration, &c., included in the cost of transportation, it would probably be within the limits of safety to say that, for this estimate half the price of the raw material would be saved in transportation if the losses of the marching ration could be saved. This would be \$2,190,000; and the total loss of material and by extra transportation, \$6,570,000.

Upon the basis of these estimates, the cost to the Government above what it need be, applied to an army of 600,000 men, would be for a single year

On the fresh beef ration, according to the extreme estimate in the

army of the Potomac.....	\$62,334,632
Or according to the basis of the cost at Hilton Head.....	38,980,957
On the marching ration.....	39,420,000
On the average bread ration.....	9,933,870

The estimate of the marching ration may, to a small extent, overlap the other two. I have assumed also that the whole bread should be fresh, whereas it is, on the march more especially, almost exclusively hard. Without access to the details of the subsistence and quartermaster's departments, it is impossible to form an accurate estimate of how large the losses are, or how great the saving that might be effected. The armies of the Gulf and of Tennessee have derived their beef in great degree from the enemy's country, and where this may take place hereafter, it would in so far reduce the cost of supplies to the Government. It may be necessary to deduct something from, or add something to the estimated loss in transportation, and what is true of the points where observation has been conducted may not be equally true in other parts of the field of war. The estimates by which I have been guided are some of them possibly too high; others, I am confident, are too low, in view of the present prices of subsistence. In the light of the foregoing figures and statements, however, it is obvious that for the total army the prospective losses to the Government, the soldier, and the country, in

the subsistence department and the quartermaster's department, connected with the purchase and movement of commissary supplies, and in the exigencies of the service, the losses which the present system inevitably entails, and which it is practicable to avoid, are of the most stupendous magnitude.

There is still another consideration. The cattle of the country are *disappearing*. Our ability to furnish the army with fresh beef is diminishing in a fearful ratio. We shall, at no distant period, approximate the condition in which the South is now.

With this loss of the larger-sized cattle first, and the smaller in their turn, there must be corresponding rise in the cost of working cattle, and of meats for domestic consumption, not applying to the term of the war only, but to the years immediately following.

THE PRESENT RATION EXCESSIVE.

It may be questioned whether there is a sound reason for the present excessive ration. The Government would have the soldier feel that he is cared for. This is well. But if the soldier can be better fed, at reduced cost, let him receive the extra allowance as an ultimate bounty, or in increased monthly pay; but not in perishable food, which it is not in human nature or the reasonable possibilities of things in active service to save, or consume, or convert into money in the absence of available transportation or a market. The company fund, it is feared, is a practical myth. In some divisions of the army it is wholly prohibited. It may be confidently asserted that it is better to increase the certainty and regularity of an adequate ration, than provide an uncertain, irregular, and sometimes deficient, though ordinarily excessive ration.

WHERE DOES THE FAULT LIE?

The fault I have endeavored to point out is not chargeable upon officers or men. It is inherent in the composition of the ration and the exigencies of the service.

COOKING UTENSILS IN THE FIELD.

To render practicable the proposed changes in the form of the meat and bread ration, cooking utensils and conveniences are required, of less number, weight and complication than those now in use. The necessary dietary equipment, assuming the bread to be supplied either as loaf bread or as hard bread, is now, for the individual soldier, a tinned iron plate, a knife, fork, and spoon, a canteen for water and a cup for coffee; for the company, baking-pans and frying-pans, and camp-kettles for soup, for boiling meats and vegetables, and for making coffee. The soldier carries his plate, fork, and spoon in his haversack, his canteen is slung over the shoulder with his haversack, and his cup is made fast to his knapsack or belt. The kettles, frying-pans and bake-pans are sometimes carried by men detailed for the purpose, but more frequently in the regimental wagon, or on the backs of mules; and on the march are often a long distance in the rear. They are sometimes captured or lost. After the fatigue of a long march or the sufferings of an engagement, they are, in the latter case more especially, almost certain as a matter of safety to be a long distance from the point where they can be of service.

From the time the Army of the Potomac left Falmouth through all the march to Gettysburg and back to Brandy Station—a whole campaign—the camp-kettles in some regiments were not once brought into service. This statement from a brigade commissary is of itself sufficient to show how unsuited the devices in use are to long campaigns in such a country as ours.

What is needed on the march is a set of utensils which shall meet the actual wants; which shall make the soldier, if necessary, independent of his mess; which shall enable him to bake, boil, stew, and fry by himself, and which set of utensils having nothing superfluous, shall occupy the least amount of space and be so attached to his equipments as to be exposed to the fewest chances of being lost. Of all that the soldier carries he parts last with his canteen. His haversack, pack, ammunition, and gun may be abandoned in his fatigue, or on the retreat, but his canteen will be the last to be dropped. It contains the drink to refresh him in his weariness. The canteen then, should be the nucleus about which

such articles connected with the preparation and serving of his food as are needed, should be arranged.

To meet these wants, I have devised a "struck up" tin or sheet iron case for the regulation canteen, consisting of two concave pans. They are held on to the canteen by a fork and spoon so locked as not to loosen, and the cord suspending the canteen is attached to one of the pans, so that the whole must be put together in order that the canteen may be carried. The other pan is provided with a staple into which the fork may be inserted, making a frying pan for stews, fries, and hashes, or a roaster for corn, wheat, peas, &c. One of the halves serves as a plate from which the soldier may eat, the other as a cup for boiling water and making coffee; the two together as a bake-pan and cover or oven in which, buried in the hot ashes, he may bake the dough from his self-raising flour. It supersedes the plate, spoon, and fork now carried in his haversack, makes the soldier independent of camp-kettles, bake pans, and frying pans, and withal, adds not more than a pound to the weight of the canteen. With a simple coffee mill, (one to a mess will occupy but a few cubic inches, and may be arranged to be attached for use to the muzzle of the gun,) the soldier can grind his plain or roasted wheat or corn, and with the canteen case realize the maxim of Napoleon that each man should be able, with the supply of raw material, to cook his food thoroughly, by himself.*

* Dr. Robert Jackson, Inspector General of the Hospitals of the English army, in his great work on the Formation, Discipline and Economy of Armies says of cooking utensils—"One quart canteen carried by the individual himself, if it be approved, (and it is undoubtedly to be preferred, that the mess be cooked individually,) a tin pint porringer, an iron spoon, a small knife and fork, a flask or canteen for water, comprise the soldiers' table and kitchen equipment for the field." The above remark which fell under my observation after I had completed my device and brought it to practical test, is the nearest approach to the solution of the problem I have met with in any writer. It remained to do little more than reduce the space required by the articles to a minimum, and render the liabilities to loss as little as possible.

Col. Delafield of the Engineers, in his report on the "Art of War in Europe," illustrates the equipment for cooking in mess in the Austrian, English, French, Russian, and Sardinian armies. The utensils are kettles and pans, conveniently arranged for transportation in wagons, or alternately by the members of the mess. The English and Sardinian Governments only have attempted to provide utensils for the individual soldier, enabling him to cook indepen-

PORTABLE MESS OVEN.

To meet the want of an oven for baking bread from the self-raising flour in camp, I have devised a simple contrivance for the mess, doing away with the necessity of an oven, and a separate fire. Plain sheet iron, 7 inches wide, is bent into a trough 4 inches wide on the bottom, 4½ inches on the top and 1½ inch deep. Two or more bent sheets are placed end to end, slightly overlapping each other. Into this trough, imbedded in hot ashes, the stiff dough, from the self-raising flour, just thoroughly stirred up with water is deposited and covered by a similar set of pans inverted, and then covered with hot ashes. In such pans the bread may be baked at the ordinary camp fire in from 30 to 45 minutes from the time the flour is taken from the barrel. In transportation, the component parts of the oven admit of being closely packed, and for each mess the weight will be trifling.

IS THERE ANY DOUBT ABOUT THE ADVANTAGES OF THE PROPOSED MODIFICATIONS OF THE ARMY RATION?

Of the convenience, healthfulness, and economy on the march of the boiled and roasted whole beef, sausaged, dried, and compressed, there can be no doubt. Of its suitedness to cavalry expeditions there can be no question. Of the practicability of its preparation there is no doubt. The processes are, individually, all old. It can, of course, be carried in bulk as easily as pork, and an equivalent in nutritive value would weigh much less.

Of the advantages of more or less fresh bread, in place of the continued use of hard bread, whether in winter quarters or on the march, and especially with raw recruits, there can be no doubt. Of the practicability of the transportation of self-raising flour in bulk,

dent of his squad. They are substantially dwarf mess kettles, strapped to the knapsack. Of the French system, Col. Delafield remarks, "that it does not admit of the soldier carrying his day's provisions, or of his having at command the means of cooking for himself, independent of the squad to which he belongs." Of the Austrian devices, he says, "they are transported in baggage wagons. This may be considered its greatest disadvantage as they are not at hand when the troops halt and most need it."

wherever hard bread can be carried, there is no doubt, since it would not injure by jolting or wetting, and occupies but about three eighths of the bulk of hard bread. It can be baked in mess without ovens; or by each soldier, on the march, wherever fires are permitted.

Of the adaptation of roasted and ground wheat to cavalry expeditions, or to rapid movements of infantry and artillery, where the extreme of light marching condition is necessary, there can be no doubt.

Nor is there any doubt that, with the aid of the devices already described, the soldier may cook his food, if necessary, from the raw material carried from his base of supplies, or obtained on the line of march.

The sausaged beef for the marching ration might be in the form of cylinders, two inches in diameter, and of such length as to roll up with the blanket. The self-raising flour, or roasted and ground wheat, might be carried in a bag in the haversack.

S U M M A R Y .

Salt pork and hard bread alone, or salt beef and hard bread alone, will not subsist an army in health. Fresh beef on the hoof, as it is usually supplied to our armies on the march, is deteriorated in quality. In all these forms of the meat ration, the bone, tendon, gristle, and water, though adding greatly to the weight and bulk of the commissary supplies, do not, on the march, add to the edible food of the soldier.

The marching ration which I have prepared, consisting of roasted and ground wheat or self-raising flour, and boiled or roasted whole beef, sausaged, dried, and compressed, is very palatable, imperishable, less expensive, of greatly reduced weight and bulk, and, of course, requiring less transportation, and will subsist an army in health indefinitely long.

At current prices* the present ration including coffee and sugar—

	Costs.	Weighs.	Measures.
With salt pork.....	23.45 cts.	32 oz.	103.7 cub. in.
With salt beef.....	24.95 "	40 "	123.8 "
With fresh beef.....	58.70 "	40 "	123.8 "

The proposed ration—

	Costs.	Weighs.	Measures
With roasted wheat.....	15.5 cts.	11 oz.	19 cub. in.
With self-raising flour.....	16.24 "	14 "	26 "
With coffee, sugar, and self-raising flour.....	22.94 "	18 "	35 "

Twenty days rations for one thousand men.

	With beef on the hoof, slaughtered and cooked, hard bread, coffee, and sugar.	With salt beef, hard bread, coffee, and sugar.	With salt pork, hard bread, coffee, and sugar.	With self-raising flour, coffee, sugar, and sausaged beef.	With self-raising flour and sausaged beef.	With roasted wheat and sausaged beef.
Cost.....	\$11,740	\$4,990	\$4,690	\$4,588	\$3,248	\$3,100
Weigh.....	50,000 lbs.	50,000 lbs.	40,000 lbs.	36,000 lbs.	17,500 lbs.	13,700 lbs.
Measure... .	1,503 cub. ft.	1,503 cub. ft.	1,201 cub. ft.	700 cub. ft.	300 cub. ft.	220 cub. ft.

*Coffee, 44 cents; sugar, 18 cents; hard bread, 7 cents; salt pork, 13 cents; salt beef, 9 cents; fresh beef, as at Hilton Head, say 36 cents per pound; flour at \$8.00 per barrel, and wheat, at \$2.00 per bushel.

The least bulky present marching ration compared with the least bulky proposed marching ration is—

In cost, 1.5 : 1
In weight, 2.9 : 1
In bulk, 5.45 : 1

The hard bread ration alone occupies nearly three and a half times the bulk of the whole proposed ration of roasted wheat and sausaged beef, and four and a quarter times the bulk of the roasted wheat alone.

A given weight of wheat would yield twice as many rations in the form of self-raising flour, as it now does of plain flour rations, and three times as many in the form of roasted wheat, with increased comfort to the men, and saving in transportation to the Government.

A given weight of fat cattle would yield, of boiled or roasted whole beef, sausaged, dried and compressed, several times as many meat rations as are now derived from the same weight of cattle transported by railway or on ship-board and slaughtered with the army in the field, while the meat would be of greatly superior quality.

The proposed ration would, in a large degree, prevent the loss of the one third of the total commissary supplies now sacrificed in the marching rations.

Finally, the proposed ration would increase the mobility of troops, and enable them to remain longer absent from a base of supplies.